Title: Decoding Word Problems

Brief Overview:

Students will learn to translate the language of word problems into mathematical expressions they can solve. Students practice translating words into mathematical operations by creating a "code book". This book will help students categorize words and phrases under the categories of: Addition, Subtraction, Multiplication and Division, Equality and Other. Students will practice using three important problem-solving strategies to solve the questions. The three strategies are simplifying, drawing a picture and working backwards.

NCTM Content Standard/National Science Education Standard:

Knowledge of Number Relationships and Computation
Knowledge of Measurement
*all four process goals

Grade/Level:

Grade 6-8

Duration/Length:

Three days (approx. 50 minutes each day)

Student Outcomes:

Students will:

- Identify key words that translate to mathematical operations (addition, subtraction, multiplication, and division)
- Brainstorm to create a "Code Book" of math vocabulary
- Identify the relationships between words and operations
- Create posters demonstrating three problem solving strategies: simplifying, drawing a picture, and working backwards
- Communicate / teach their ideas for solving real world problems: orally, visually and mathematically

Materials and Resources:

- Morse Code key
- Instructions for creating their own "Top Secret" book
- "Code Book"- Teacher Resource Section

- Stapler
- Hole punch
- Colored pencils
- Transparency – Teacher Resource Section
- Poster board paper

Development/Procedures:

Lesson 1 – The Code Book

> Pre-assessment – Students should read, have basic fact skills and have simple categorization skills.
>
> Launch – As the students arrive the "Warm-up" is on the board or on an overhead transparency (TR1).

Warm up

```
-... .-. . .- -.- .. -. --. / - .... . / -.-. --- -.. .
```

> Immediately the questions may be:
> *"What's that?"*
> *"How could I figure it out?"*
> *"What does that have to do with math?"*
> Lead the discussion until the students state that they need a "Key" to decode the message.
> Pass out the "Morse Code" hand out (TR2). Ask them to decipher the message on the board.
> Teacher asks: "What was your translation?"
> Next, with a partner, have them create a simple coded message and hand it to another partner pair to decode.
> Next, have the students brainstorm and write on the board all the symbols we use in math that have meaning.
>
> Teacher Facilitation part 1 – Present to the students the similarities between math word problems and codes. Explain how mathematics itself is a code and how math symbols correspond with language. For example, the symbol '+' can be viewed as a code for addition. The word 'and' can also be a code for addition. Ask students to provide a simple math expression or write   + 5 on a blank overhead or chalkboard. Prompt students to offer phrases or sentences to describe this expression. Write their responses next to + 5 to illustrate the translation.

Student Application – Have the students in pairs or small groups list as many different ways that they can write the following math symbols in words:

Addition   Subtraction Multiplication Division   Equality   Other

Place Teacher Resource 3 (TR3) on the overhead or draw on the board 6 columns labeled as above. As students come up with ideas they can fill in the chart on the board. If one is incorrect have the class discuss and determine the correct placement.
Once the students think they are done, check over the answers to be sure they are all correct and spelled correctly.

Teacher Facilitation part 2 – Give each student 1 plain piece of paper and 2 sheets of lined paper or use Teacher Resources 4a and b and 5. Have them fold each in half lengthwise and staple the three sheets at the crease, close the booklet, and hole punch. Explain to the students that they now have a "Code Book". Have the students be creative with the cover by coloring it. Then ask the students to fill in the "Code Book" with the information from the board. Note that the "Code Book" can be placed in their three-ring binder and is available for problem solving as well as to be added to throughout the year.

Embedded Assessment – Using the following rubric, determine each student's progress towards the understanding of codes and the concept of decoding as applied to mathematical word problems. Use a scale from 1 to 5, 5 being mastery.

Rubric 1

	Names				
Objectives					
Understands the purpose of codes, and situations where codes are useful					
Understands the relationship between codes and mathematical word problems					
Constructed a code book according to instructions					
Brainstormed different symbols and vocabulary					
Correctly categorized symbols and vocabulary into +, - , ×, ÷, and =					

Reteaching/Extension –

- Reteach: Teacher will ask the student to choose a number between 1 and 10, then the teacher will write that number on a piece of paper. Then, using their number construct an addition problem with symbols and words.
- Extend: Students will create a story using word questions or word problems for their team to decipher using math symbols.

Lesson 2 – Strategies

Pre-assessment: Ask Questions that refer back to the previous day's lesson.
Possible questions might include the following:
"What is Morse code?"
"What is the relationship between math symbols and language?"
"Do you think that math is a universal language?"
"Is there any language that is considered a universal language?"

Launch: As the students arrive the "Warm-up" is on the board or on an overhead transparency (TR6). Today the students will encounter the code but when it is translated, it is in French. Once the message is decoded they must now have a "Strategy" to figure out what it means. This leads into a discussion of the three strategies we will discuss today.

"Mon petit chou chou" in Morse code is:

-- --- -. / .--. . - .. - / -.-. .... --- ..- / -.-. .... --- ..-

Morse Code website:
http://www.soton.ac.uk/~scp93ch/morse/index.html?http://www.soton.ac.uk/~scp93ch/morse/trans.html

Teacher Facilitation – Say the following to the class: "Once we translated the Morse Code into letters, we can translate words into math symbols. But as in the warm-up today we found that just decoding the Morse Code is not always going to make the problem easy to solve. We need a second step to go from the French to English. In a math word problem we may translate the problem but not know how to solve the problem. Although there are many strategies, we will look at 3 strategies:"

1) Using the "**Drawing a picture or chart**"
2) Using **"Working Backwards"**
3) Using **"Simplify"**

Strategy Number 1 – **Drawing a picture or chart**

Problem A:

You need to record the temperature for a science project. Yesterday's temperature was -3°C. Today's temperature is 2°C. What is the difference in temperature between today and yesterday?

a) Draw a number line to represent thermometer.

```
    6
    5
    4
    3
    2
    1
    0
   -1
   -2
   -3
   -4
   -5
   -6
```

b) Then, plot out today's and yesterday's temperature on the number line.

```
    6
    5
    4
    3
  • 2
    1
    0
   -1
   -2
  • -3
   -4
   -5
   -6
```
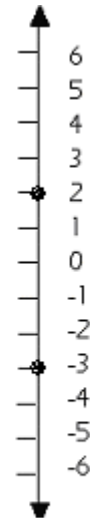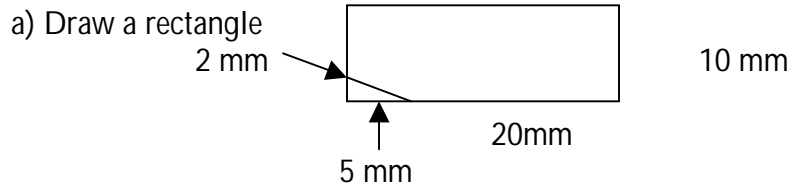
c) Count how many points from 2 to –3

You will get 5

So, the difference in temperature is 2 – (-3) = 5

Problem B:

   A corner was clipped from a 10mm by 20mm rectangular piece of paper. The lengths of the sides of the triangle that were cut off are 2mm and 5mm. What is the area of the rectangle without the corner?

a) Draw a rectangle

    2 mm   10 mm

                    20mm

   5 mm

b) Cut off a corner and label the sides.

c) See that cutting off the pieces will subtract the triangle from the rectangle. You need to find the area of the rectangle and the triangle and subtract the triangle from the rectangle.

d)   Area of the rectangle   200 mm
        - Area of the triangle   - 10 mm
   Area of the rectangle w/o the corner.   190 mm

Practice Problems with answers
1) How many square feet of tile would be needed to tile a bathroom floor six feet wide and six feet long?
2) Marlene stores her video games in a pile that stands 10 inches high. If each video game is 5/8 inches thick, how many video games does Marlene have?
3) If the temperature outside in the morning was 5 degrees Fahrenheit below zero and the temperature at noon was 20 degrees Fahrenheit above zero, what was the change in temperature in degrees Fahrenheit?

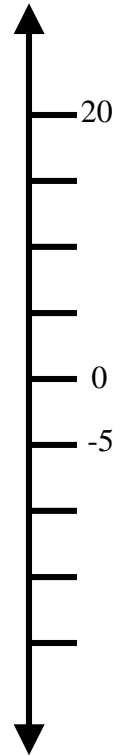Answers: 1) Six tiles by six tiles for a total of 36 tiles
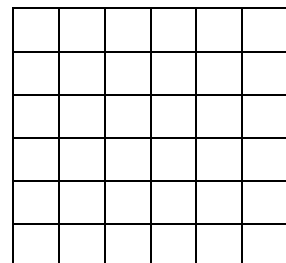
Answers: 2) 10inches divided by 5/8 inches = 16 videos
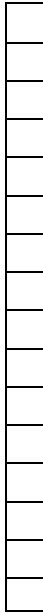
Answers: 3) Draw a number line and count. 25 degrees

20

0

-5

Strategy Number 2 – **Working Backwards**

Problem A: The mean of four numbers is 25. Three of the numbers are 17, 23 and 25.
                 What is the fourth number?

a) Draw a shell of how to find the average

$$\underline{\quad}$$
$$\underline{\quad}$$
$$\underline{\quad}$$
$$+\underline{\quad}$$
$$\div\ 4\ =\ 25$$

b) Now fill in the three numbers

         17
         23
         25
     $+\underline{\quad}$
         $\div 4 = 25$

c) If a number divided by 4 is 25. Then 25 x 4 should give me that number.
                        25 x 4 + 100

d) If 17 + 23 + 25 + __ = 100, then if you subtract 17, 23, 25 from 100 you
could find the number. OR   you could add 17 + 23 + 25 = 65 and subtract from
100 to get 35.

e) The final answer filled in is:

         17
         23
         25
     $+\ 35$
     $100 \div 4 = 25$

Problem B: If 18 students in the class are boys and there are 32 students all
together, how many of the students are girls?

Answer: 32 – 18 = 14

Practice Problems
1) If the area of a triangle is 10 square units and the base of the triangle is 4 units, what is the height of the triangle?
2) On her way home from work, Molly spent one dollar to buy a box of cookies, then she went to a gift store to buy a special gift for her sister, leaving her with only one tenth of the money she had left after buying the cookies. Molly also spent $3 on flowers to decorate her home. She was hungry after all of this shopping and spent half of the money she had left on dinner for that evening. At the very end of the day Molly had $5 left in her purse. How much money did Molly have when she left work?

Answers:
1) 1/2bh = area of a triangle   ½ x 4 = 2, what times 2 = 10? 10/2 = 5 height = 5
2) $5 x 2 = $10, $10 +$3 = $13, $13 x 10 = $130, $130 +$1 = $131 Molly had $131 when she left work.

Strategy Number 3 – **Simplify**

Problem A: Convert 9.68 km to meters.

If you don't know what to do because of the decimal, go to what you do know. 1 km = 1000 m

Think-   2 km = 2000 m
               3 km = 3000 m

               9 km = 9000 m
               10 km = 10000 m

You see that 9.68 km is between 9 km and 10 km.

The answer must be between 9000 m and 10000 m.

You see that 9680 would be between 9000 and 10,000 so the answer must be 9680 m.

Problem B: 75% of the questions on Jack's test were multiple choice. Rewrite 75% as a fraction or a decimal and determine how many of the 24 questions were multiple choice.

Answer:

$\frac{3}{4} \times 24 = 18 \; or \; .75 \times 24 = 18$

Practice Problems
1) When the forth multiple of eight is subtracted from the eighth multiple of six, what is the difference?
2) What is the sum of the first 10 positive integers?

Answers:
1)

$8 \times 4 = 32$

$6 \times 8 = 48$

$48 - 32 = 16$

2) Sum from 1 to 10 = pairing summands from left and right ends toward the middle
(1+10) + (2+9)+(3+8)+(4+7)+(5+6) = 11 x 5 = 55

Student Application - Assign additional problems to each group. Each student must demonstrate at least one strategy to their team. Also have students create word/math problems or scenarios of their own for their group to solve and demonstrate for each other.

Embedded Assessment

Rubric 2

	Names				
Objectives					
Involved in class discussion					
Comprehends the drawing strategy					
Comprehends the simplifying strategy					
Comprehends the working backwards strategy					
Solved the word problems using the three strategies taught today					

Reteaching/Extension –
- For those who have not completely understood the lesson demonstrate for that student that an equation that has multiple steps or operations can be simplified into parts, demonstrating each operation separately. Draw a picture to illustrate a distance or number line problem. Explain that in some instances, the sequence of events is extremely important, (ie: order of operations tells us you cannot put addition before multiplication). Sometimes you must work a problem backwards to find the answer.
- For those who have understood the lesson, challenge these students to try to write a creative story (1-3 paragraphs in length) that can be solved using one or all three strategies.

.

Lesson 3 – Posters

Preassessment – Ask students to explain how they derived their answers for the previous lesson.

Launch – State: On the job, many people use <u>tools</u> to work efficiently. Our strategies are tools for solving math problems and math word problems." Prompt students by asking: "*How can they illustrate the three strategies for problem solving?*"

Teacher Facilitation - Explain to the students that they will be creating a visual tool (a poster) to hang in the classroom to help them remember and utilize these strategies for future problem solving.

Student Application – Have the students brainstorm for at least 5 minutes as a group to decide how they best wish to illustrate their ideas about the three strategies. Using poster paper, markers, crayons, or colored pencils have students create their posters. (20 - 30 minutes)

Embedded Assessment - Canvas the classroom to be sure that students ideas reflect understanding as they brainstorm their ideas. Completion of a poster or visual aid.

Reteaching/Extension
- For those students who have not completely understood the lesson, ask that student : *Would they be able to decode the morse code message without the "key"?* Explain that the "key" is a visual "tool" for helping them translate the message, and that they are creating a visual tool (a poster) for their classroom to help them translate difficult math problems into workable solutions.
- For those students who have understood the lesson, ask these students to be as creative possible with their posters and to demonstrate their ideas to their team or to the whole class.
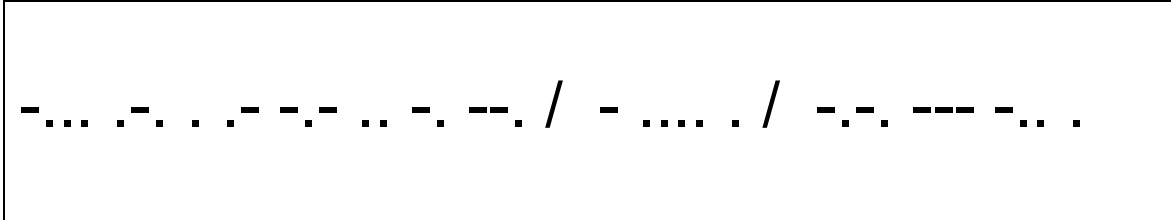
Summative Assessment:

Review the two rubrics.

Authors:

April Smith
Kent School
Kent County, Maryland

Chien-Hsiang Chou
Pennsylvania School for the Deaf
Philadelphia, PA

Donna Anderson
Salisbury Christian
Salisbury, Maryland

-... .-. . .- -.- .. -. --. / - .... . / -.-. --- -.. .

Morse Code Alphabet

The International morse code characters are:

A	.-	**N**	-.	**0**	-----
B	-...	**O**	---	**1**	.----
C	-.-.	**P**	.--.	**2**	..---
D	-..	**Q**	--.-	**3**	...--
E	.	**R**	.-.	**4**	....-
F	..-.	**S**	...	**5**	.....
G	--.	**T**	-	**6**	-....
H	....	**U**	..-	**7**	--...
I	..	**V**	...-	**8**	---..
J	.---	**W**	.--	**9**	----.
K	-.-	**X**	-..-	**Fullstop**	.-.-.-
L	.-..	**Y**	-.--	**Comma**	--..--
M	--	**Z**	--..	**Query**	..--..

Addition	Subtraction	Multiplication	Division	Equality	Other

Top Secret…

Math Symbols

_____

Equality/Other

_____

Code Book Inside Pages (Run off "two sided " with the back upside down.)

_____

_____

-- --- -. / .--. . - .. - / -.-. .... --- ..- / -.-. .... --- ..-
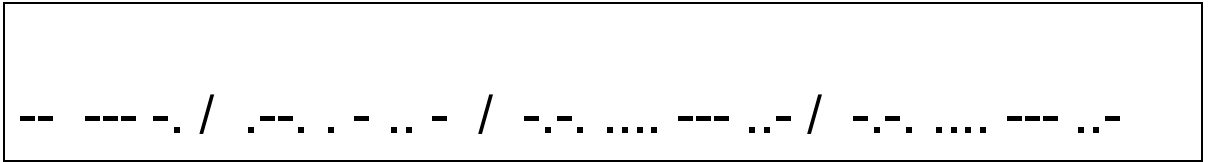
Lesson 1: Rubric

Objectives	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Understands the purpose of codes, and situations where codes are useful																				
Understands the relationship between codes and mathematical word problems																				
Constructed a code book according to instructions																				
Brainstormed different symbols and vocabulary																				
Correctly categorized symbols and vocabulary into +, - , ×, ÷, and =																				
TOTAL																				

KEY: 5 is high.

      1 is low.

Lesson 2: Rubric

Objectives	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Involved in class discussion																				
Comprehends the drawing strategy																				
Comprehends the simplifying strategy																				
Comprehends the working backwards strategy																				
Solved three word problems using the three strategies taught today																				
TOTAL																				

KEY: 5 is high.
   1 is low.